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LENGTH OF DAY INSTEAD OF TEMPERATURE CONTROLS TIME OF FLOWERING AND FRUITING*

For generations scientists have known that sunlight was necessary for normal growth of most kinds of plants, and, although the summer sun might occasionally become too hot, they have understood that it could not cause any injury except perhaps the injury due to burning. A recent discovery by W. W. Garner and H. A. Allard, of the Bureau of Plant Industry, United States Department of Agriculture, shows that, entirely apart from any effect of burning, it is possible for plants to have too much daylight or, in other words, too many hours of daylight in comparison with the number of hours of darkness. Too long a day as well as too short a day will prevent many kinds of plants from ever reaching their stage of flowering and fruiting.

Furthermore, the intensity of the light has very much less significance upon the growth of the plant than has usually been supposed. Greenhouse experiments prove that the flowering and fruiting period of practically any plant can be made to take place at any time of the year by darkening the greenhouse in the morning and evening if the day is too long, or by lengthening the day by artificial light if the day is too short. This new theory of controlling flowering and fruiting of plants undoubtedly will be used by florists and other greenhouse operators. For example, violets bloom only during the comparatively short days of spring; but if violet plants are covered with light-proof boxes at night and not uncovered until the sun is about half an hour high each morning during the summer time, violets can be forced to bloom again in the summer. Spring flowers and spring crops happen to be spring flowers and spring crops because the days at the season of their flowering and fruiting have the proper number of hours of daylight. Correspondingly, the early summer flowers and crops must have a longer period of daylight. This has been proved as to a large number of plants, and the scientists believe that the principle will hold throughout the higher forms of plant life, and that it is probably applicable to animal life as well.

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* From a recent news bulletin of the U. S. Department of Agriculture. The *Journal* of Agricultural Research recently contained an article of which this is a popular account. The work is perhaps the most significant in recent ecological research. An apparent exception to the theory is the fact that the Lapland Rhododendron, brought from the summit of Mt. Marcy to the Brooklyn Botanic Garden, was kept all winter in the dark and flowered at Brooklyn six weeks before the normal period above the timber line. In this case it flowered only about four weeks after the winter covering was removed.—ED.

Reproduction Depends on Day Length

The plant can not attain sexual reproduction, it has been shown, except when it is exposed to a favorable length of day. The requirements, however, differ widely with species and varieties. But a length of day that is unfavorable to reproduction may be favorable to growth. Under that condition, the plant continues its vegetative development profusely and indefinitely without bearing fruit. A length of day may be found that is favorable both to sexual reproduction and vegetative growth. That tends to bring about the "ever-bearing" type of fruiting.

By employing dark chambers to shorten the period of light and artificial lights to extend it, scientists of the Department have shortened or lengthened the life cycle of plants, have made some of them complete two cycles in a single season, have brought others into flower and fruit months in advance of their regular time and, with still others, have greatly delayed and even completely prevented fruiting.

Long series of tests have been made with soy beans, tobacco, wild aster, climbing hempweed, beans, ragweed, radish, carrot, lettuce, hibiscus, cabbage, violets, goldenrod, spinach, cosmos, iris, beggartick, buckwheat, and various other plants.

A test made with Biloxi soy beans will show how the principle works. For the test plants the day was shortened by several hours. That is, they were exposed to the light only from 10 o'clock in the morning till 3 o'clock in the afternoon. They were first placed in the dark house on May 20. Control plants, otherwise treated exactly like the test plants, were left exposed to the light from dawn till dark. The first blossoms appeared on the dark-house plants on June 16. No blossoms appeared until September 4 on the plants that were left in the light all day. But the dark-house plants averaged only 6 or 7 inches high, while the plants that were left in the light all day grew to an average height of 57 or 58 inches.

These plants required a short day and a long night for flowering and seed-bearing. In tests with other plants, just the opposite was found to be true. The plants that were left in the light all day did not grow luxuriantly, but produced flowers and seed, while those that were kept in the dark part of the day made abundant growth, but produced no seed or else were greatly retarded in producing seed.

TEMPERATURE HAS LITTLE INFLUENCE

Temperature appeared to exert no influence in these tests. The results were the same, even when the temperature was higher in the dark house than on the outside. Another striking illustration of the relative unimportance of temperature is the fact that plants kept in the dark for a part of the day underwent, in midsummer, the changes that in nature come in the fall and have always been attributed to lower temperatures. This, also, was true even when the dark houses registered a higher temperature than that of the outside summer atmosphere.

The results obtained by artificially extending the period of light are just as interesting as those obtained by artificially shortening it. The artificial illumination, in a test with iris, was so arranged as to give 18 hours of continuous light in a greenhouse during the winter. Control plants were kept in a similar greenhouse with no artificial light. The test was begun on October 20, 1919. In the greenhouse where daylight was supplemented with electric light the plants made rapid growth, soon attained normal size and produced blossoms on December 24. The plants in the greenhouse where no artificial light was used, though it was kept at the same temperature, remained practically dormant and showed no tendency to blossom as late as February 12, 1920.

IMPORTANT INFLUENCE ON CROP YIELDS

The influence of this discovery on crop yields is likely to be of no little importance. The length of day is proved to be the most potent factor in determining the relative proportions between the vegetative and fruiting parts of many crop plants. Indeed, fruiting may be completely suppressed by a day either too long or too short. The advance in agricultural practice which may come through this new discovery will have to be brought about largely by plant breeders and other crop specialists. For instance, it will prove of material significance in the future planning of cropping systems for different regions, especially where consideration of new crops from different latitudes is necessary.

This new principle undoubtedly explains the erratic behavior which has been observed with many crops when they are shifted to different latitudes, and may also clear up the conflicting results of variety tests and field tests conducted with the same crops but in different regions. The experiments have shown, for instance, that ragweed requires for flowering a stimulus that is afforded by the shortening of the days and lengthening of the nights. It does not come into flower until the period of daylight falls below 15 hours. In the latitude of Washington, that comes about July 1. But if ragweed seed should be taken to northern Maine and planted, the plants would not experience a length of day below 15 hours until about August 1. Therefore, they could not come into flower until after August 1 and, though the vegetative growth might be very rank, they could not mature seed before killing frosts intervened. The long days, therefore, make it impossible for ragweed to perpetuate itself in that latitude. On the other hand, plants that get their flowering stimulus from a long day could not perpetuate themselves through seed formation at the equator, where the day never exceeds 12 hours.

EXPLAINS LUXURIANT GROWTH IN NORTHERN LATITUDES

This principle affords the clue to the fact that many plants grow most luxuriantly near the northern limit of their range. The long northern day allows them to attain their maximum growth before the shorter day intervenes to check vegetative growth and start the reproductive process.

It may be found eventually, say the men who worked out the principle, that the animal organism, also, is capable of responding to the stimulus of certain day lengths. They believe that the migration of birds may be an illustration. Direct response to such a stimulus, they say, is more in line with modern teachings of biology than theories which assume that birds migrate as a matter of instinct.

PIN OAK IN NEBRASKA

By Raymond J. Pool

In a handbook of Nebraska trees published in March, 1919, I made the statement that: "Pin oak does not occur naturally in Nebraska, but it occurs in north central Missouri and eastern Kansas, so we may expect it to wander into our state some day via the southeastern corner." The statement is rather interesting in view of the fact that pin oak was discovered in southeastern Nebraska during the summer of 1919.

Early in September, 1919, Mr. Thomas D. Howe, collector for the department of botany in the University of Nebraska, collected specimens from an oak tree growing near Table Rock, Nebraska, and he believed that the tree was pin oak, *Quercus palustris* Du Roi. Mr. Howe brought his specimens to the department of botany where his earlier judgment was confirmed by further study and comparison by several members of the department.

The tree in question is about 20 feet in height with a trunk diameter of about 5 inches, breast high. It is growing in association with red oak at the edge of the natural oak woodlands on the north-facing slope of a low hill about 1½ miles northeast of Table Rock. That town is in Pawnee county, about 35 miles from the extreme southeastern corner of the state, but only about 15 miles from the Kansas-Nebraska state line.

The nearest house is a quarter of a mile from where the tree stands on the edge of the forest where the forest gives way to a cultivated field. It would seem very unlikely that anyone could have planted the acorn in such a place; there would be no